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AN EXPLORATORY INVESTIGATION OF SELECTED MEASURES OF RATE OF LEARNING.

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THREE MEASURES OF LEARNING RATE WERE EXPLORED--(1) NUMBER OF UNITS COMPLETED PER YEAR, (2) TIME TO COMPLETE GIVEN UNITS, AND (3) AMOUNT OF CONTENT MASTERED PER DAY. THE SUPPOSITION WAS THAT THESE MEASURES COULD BE USED TO PROVIDE ESTIMATES OF INDIVIDUAL PROGRESS IN THE ELEMENTARY CLASSROOM ENVIRONMENT. ONLY ONE OF THESE MEASURES (AMOUNT OF CONTENT MASTERED PER DAY) SHOWED MINOR DEGREES OF CONSISTENCY OVER DIFFERENT UNITS OF INSTRUCTION, AND FINDINGS OF THE STUDY SUGGESTED THAT LEARNING RATE WAS NOT A GENERAL CHARACTERISTIC OF THE LEARNER. IT WAS TENTATIVELY CONCLUDED THAT RATE OF LEARNING IS SPECIFIC TO THE LEARNING TASK AND IS NOT A GENERAL PARAMETER THAT APPLIES TO ALL LEARNING FACTORS. RELATED REPORTS ARE ED 010 205 THROUGH ED 010 211 AND ED 010 519 THROUGH ED 010 523. (GC)

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AN EXPLORATORY INVESTIGATION OF SELECTED MEASURES OF RATE OF LEARNING[1]

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It is probably safe to assume that the general concept of "rate of learning" has always been of some interest to teachers, to parents, and to other persons concerned with the problem of instruction. Anyone involved in teaching soon notes that some individuals learn quickly, others at a moderate pace, and some quite slowly. In fact, many of the major problems of the typical classroom teacher and some of the inefficiencies of traditional classroom instruction are associated with this variability in rate of learning. The IPI program together with many other programs that are designed to adapt instructional programs to individual differences among students look upon differences in rate of learning as one of the key variables which such adaptations must accommodate.

Despite this general concern for the rate at which school learning takes place most studies of rate of learning have been carried out under laboratory conditions rather than in the classroom. One reason for this, of course, is the complexity involved in getting a useable measure of rate and of exercising some control over the number of factors that can operate to affect it. Perhaps an even more important reason is the difficulty of finding or of setting up classroom situations where provision is made for variation among students in the rate at which they learn.

[1]The research and development reported herein was performed pursuant to a contract with the United States Office of Education, Department of Health, Education, and Welfare under the provisions of the Cooperative Research Program.

The project on Individually Prescribed Instruction offers a unique opportunity for studies of rate of learning since it involves considerable variability in rate and provides for frequent measures of status and progress. Because of this opportunity and since rate of learning is a variable which is quite central to the basic purpose of the project, the staff is making a rather continuous study of this variable. A first phase of this study has involved the identification of several possible measures of rate and an exploratory investigation of some of the properties of these measures.

Rate: Number of Units Completed Per Year

Under Individually Prescribed Instruction the pupil works through a sequence of units of work in each such area as reading and arithmetic. A pupil works at his own pace, and when he masters one unit he moves on to the next. Under these conditions a rather obvious measure of rate of learning is the number of units that a pupil masters in a given period of time, such as a school year.

A first question raised concerned the consistency of this measure over subject-matter areas. This was investigated by determining the correlation between the number of units completed in one school year in arithmetic and in reading for the 70 students in the intermediate level of the school. The resulting correlation of +.387 is presented in Table I.

Table I. Correlation of Number of Units Completed in Mathematics and Number of Units Completed in Reading In One School Year

School Level	N	r
Intermediate	70	+.378**

**Significant at .01 level

This suggests that there is a minor degree of consistency between rate in these two subjects when number of units completed in a school year is used as the measure.

This measure was investigated further by determining the correlations between it and IQ. As can be seen by the results summarized in Table II, there is essentially no correlation between IQ and this measure of rate either in reading or arithmetic.

Table II. Correlation of IQ with Number of Units Completed in One Year

Variables Correlated	School Level	N	r
IQ with number of math units	Intermediate	66	+.148
IQ with number of reading units	Intermediate	68	-.012

Since IQ is typically assumed to be a predictor of how quickly a child can master academic tasks, this lack of correlation between it and rate of learning was quite interesting. In an attempt to shed some further light on this matter one other relationship was investigated. This was the relationship between IQ and level of initial placement in the IPI sequence. Since rate had been measured in terms of number of units, level of initial placement was measured in much the same way. That is, a student's level was determined by noting the units with which, on the basis of pre-tests taken at the beginning of the school year, he started his work. All units in the curriculum sequence that were prerequisite to these units were counted as having been mastered.

A total of all such units mastered in all of the sub-areas in arithmetic then provided a measure of the pupil's level of initial placement. The correlation of these measures with IQ is presented in Table III.

Table III. Correlation of IQ with Level of Initial Placement in Arithmetic for Each Grade Level Group

Grade Level	N	Correlation
1	27	+.396*
2	27	+.421*
3	30	+.392*
4	30	+.641**
5	21	+.504*
6	22	+.810**

*Significant at .05 level
**Significant at .01 level

These data indicate that there is a moderate correlation between IQ and amount of content that the pupil had mastered prior to entering the program.

In summarizing the correlations presented in Tables II and III it can be said that these results suggest that level of attainment reached prior to entering IPI is correlated with IQ but that actual rate of progress during one year of Individually Prescribed Instruction is not correlated with IQ.

In considering number of units completed in a school year as a measure of rate of learning certain points must be kept in mind. First, of course, it is a practical and meaningful measure in that it indicates how quickly a pupil can progress through a sequence of course material when that progress is affected by all of the factors that play a part in classroom learning. That is, speed, when measured in this way is

influenced not only by how quickly the learner can master small segments of the learning task but also by such other things as how well he can transfer abilities from one task to another, how much he learns through incidental learning that takes place outside of the classroom, the entering behaviors he brings to a specific learning task, and a number of similar factors. Another difficulty in using number of units completed as a rate measure is that it is essentially impossible to make the units equivalent in difficulty, in their general effectiveness, or in the average time needed for mastery. This means that one cannot say, for example, that a pupil who has completed 12 units has covered twice as much material as one who has completed 6 units. Because of all of these complicating factors which affect this measure of rate of learning, additional measures have been investigated.

Rate: Time to Complete Given Units

One way of avoiding the problem of the varying difficulty of units is to measure rate in terms of the time required to cover one given unit or some limited number of specific units. The measure here, for example, could be the number of days required to master the first unit (or Level A) in addition. Again, with this measure, a first question that was studied was whether or not there is any consistency over units. To investigate this question, the correlations of various pairs of measures were computed. These are presented in Table IV. Note that the first two correlations under reading and the first two under arithmetic are correlations between rates in working through the same content area at two successive levels. In all four cases these correlations are not

significantly different from zero. This same lack of correlation is also seen in the relationship between rate in two different topics at the same level in the case of G comprehension and G structural analysis. However, when rate in C addition was correlated with rate in C subtraction, a significant negative correlation, -.595, was obtained. Since this was a rather puzzling relationship, it was investigated further by identifying all those pupils who had completed two successive levels in addition (C and D) as well as the same two successive levels in subtraction. This permitted the calculation of the final correlation presented in Table IV which is again a significant negative value. This rather puzzling relationship is being studied more intensively particularly in terms of its

Table IV. Correlation Between Time Spent In One Unit and Time Spent in Another Unit for Selected Pairs of Units

Units Correlated	N	r
Reading		
F Comprehension and G Comprehension	36	+.172
G Comprehension and H Comprehension	25	-.207
G Comprehension and G Struct. Anal.	31	+.039
G Struct. Anal. and H Comprehension	26	-.276
Arithmetic		
B Numeration and C Numeration	25	+.050
C Subtraction and D Subtraction	32	-.007
C Addition and C Subtraction	44	-.595**
C Addition plus D Addition and C Subtraction plus D Subtraction	22	-.440*

*Significant at .05 level
**Significant at .01 level

implications for our curriculum materials and procedures. One possible explanation proposed by our staff is that students who spend considerable time on addition master number combinations and relationships so well

that this knowledge is easily transferred over to the mastery of subtraction, and little time is needed to master these latter skills. If this explanation is substantiated, this would have definite implications for such things as the level of mastery required before a student is permitted to move on from addition to subtraction.

It is rather obvious from the figures in Table IV that learning rate as measured by time spent on units is not consistent over units. It seems to depend upon the specific unit being studied and not to be a general characteristic of a student.

As with the other measures of rate that were investigated, this measure involving time spent on given units was also studied with respect to its correlation with IQ. Data on this relationship are presented in Table V. In view of the inconsistency of this measure, the variability in these correlations with IQ and the fact that most of them are not significantly different from zero would be anticipated and Table V serves to substantiate this.

Table V. Correlation Between IQ and Time Spent in a Unit for Selected Units

Unit	N	Corr. with IQ
Reading		
F Comprehension	64	-.14
G Comprehension	44	+.14
H Comprehension	48	.00
G Structural Anal.	37	+.11
Arithmetic		
B Numeration	35	+.17
C Numeration	44	+.04
C Subtraction	59	-.16
D Subtraction	49	+.45**
C Addition	54	+.02

**Significant at .01 level

Rate: Amount of Content Mastered Per Day

It should be noted that in both of the measures of rate of learning discussed thus far, that is, number of units completed in a school year and time needed to complete a unit or given set of units, no account is taken of any mastery of the material in a unit that a pupil may have before he starts work in it. This mastery, which may be considered to be a function of the student's ability to extrapolate from what he learns in one unit to actually acquire abilities taught in succeeding units, is, with these measures, considered to be a factor which helps to determine the pupils over-all rate of learning, and, hence, permitted to operate.

Another possible measure of rate of classroom learning, however, would be one that would take into account how much the student already knows of the content of a given unit at the time he enters it and hence how much he has left to master in his study within the unit. Since in the IPI program a pupil always takes a pre-test on a unit before starting work in it, this makes it possible to measure what he has to learn in a unit by determining the difference between his pre-test score and a score indicating mastery of the unit. A measure of rate can then be determined for each pupil by dividing this measure of how much he learns in a unit by the time he spends studying in it.

Using this rate measure, an investigation was again made of the relationships between rate in one unit and rate in another. Correlations representing such relationships are presented in Table VI. It is interesting to note that here there is some tendency toward a moderate relationship between rate in one unit and rate in another. Comparing this moderate

Table VI. Correlations Between Rates in Selected Pairs of Units Using a Rate Measure Based on Amount of Material Left to Learn in a Unit

Units Correlated	N	r
C Addition and C Subtraction	31	+.45**
C Addition and C Fractions	32	+.39*
C Numeration and C Addition	23	+.020
D Subtraction and D Fractions	18	+.357
D Fractions and D Geometry	24	+.148

*Significant at .05 level
**Significant at .01 level

relationship with the lack of relationship found when previous measures of rate were used suggests that rate as measured by time to master a given amount of material may have some consistency over various types of lesson content but that the ability to extrapolate is not a consistent factor within the individual pupil operating over all types of lesson content.

An investigation of the correlation of this third rate measure with IQ resulted in the data presented in Table VII. These data suggest

Table VII. Correlation Between IQ and Rate as Measured by Amount of Content Mastered Per Day

Unit	N	Corr. with IQ
C Addition	35	+.120
C Subtraction	50	+.120
C Fractions	47	+.37**
D Subtraction	36	+.093
D Fractions	50	+.235
D Geometry	29	+.168

**Significant at .01 level

a somewhat inconsistent pattern which might have been anticipated on the basis of previous data.

In summary, this study has explored three possible measures of rate of learning that might be employed in classrooms that provide for individualized progress. Although one of these measures shows a minor degree of consistency over different units of instruction, the results suggest that rate of learning is not a general characteristic of the learner. This would seem to support Carroll's contention that "...rate of learning is specific to the learning task and it is not a general parameter that applies to all learning factors."[1] Perhaps the degree of complexity in factors affecting it is at least that suggested by Carroll's learning model.[2] This possibility poses a challenge in the identification and measurement of these related and interacting factors.

[1]Carroll, John B., "Comments on Cronbach's Paper," paper presented at the Conference on Learning and Individual Differences, University of Pittsburgh, April, 1965.

[2]Carroll, John B., "A Model for Learning," Teachers College Record, Vol. 64, 1963, pp. 723-733.